Vol. XIII. APRIL, 1897. No. 2.

JOURNAL

OF THE

New York Microscopical Society

EDITED BY

REV. J. L. ZABRISKIE,

28 REGENT PLACE, FLATBUSH STATION, BROOKLYN, N. Y.

CONTENTS.

		PAGE.
I.	Cutting and mounting sections of Cereal Grains and Starchy Tubers. By J. D. HYATT. [Plate 63]	19
II.	The Bausch & Lomb Filar Micrometer. By P. H. DUDLEY, C.E. [Illustrated]	25
III.	Classification of Sands and Silts. By A. A. JULIEN, Ph.D	34
IV.	Color and Color-Patterns of Moths and Butterflies	39
V.	Bausch & Lomb Reversible Mailing Cases [Illustrated]	41
VI.	Proceedings	43
VII.	Publications received	49

New York:

PUBLISHED FOR THE SOCIETY,

QUARTERLY.

PRESS OF DOUGLAS TAYLOR & CO.
No. 8 WARREN STREET.
1897.

[Entered at the Post-Office at New York as second-class matter.]

New York Microscopical Society.

OFFICERS FOR THE YEAR 1897.

President,	Frank D. Skeel.
Vice-President,	F. W. Leggett.
Treasurer,	James Walker.
Recording Secretary,	George E. Ashby.
Corresponding Secretary,	J. L. Zabriskie.

Committee on Admissions.

Henry C. Bennett, George H. Blake, Thomas S. Nedham, Frederick Kato, W. J. Lloyd.

Committee on Publications.

J. L. Zabriskie, Frank D. Skeel, George W. Kosmak, James Walker, H. A. Parmentier.

Regular Meetings on the first and third Fridays of each month, from October to June, inclusive, at 8 P. M., at No. 64 Madison Avenue, New York City.

JOURNAL

—OF THE—

NEW YORK MICROSCOPICAL SOCIETY

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS.

PUBLISHED QUARTERLY.

All communications for the JOURNAL, all subscriptions, and all exchanges, should be addressed to the editor, Rev. J. L. Zabriskie, 28 Regent Place, Flatbush Station, Brooklyn, N. Y.

Terms of Subscription:—In the United States, Canada and Mexico, One Dollar per annum, beginning with the January number. In other countries, One Dollar and Twenty-five Cents per annum.

F. W. DEVOE & CO.,

(ESTABLISHED IN 1852.)

Fulton Street, corner of William Street,

NEW YORK.

ARTISTS' MATERIALS,

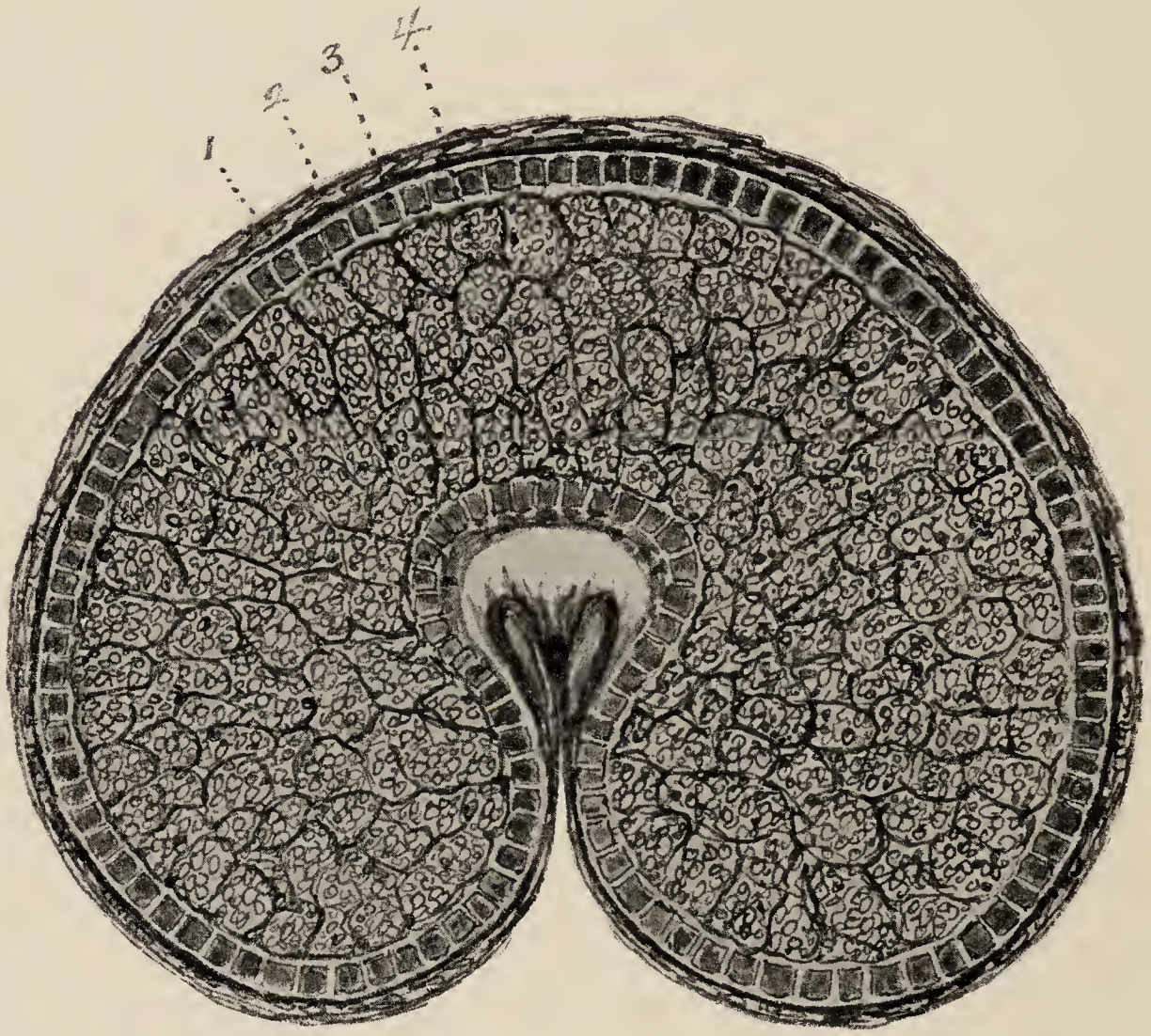
OF ALL KINDS,

FINE BRUSHES, MATHEMATICAL INSTRUMENTS,

COLORS, VARNISHES.

Digitized by the Internet Archive
in 2019 with funding from
Wellcome Library

https://archive.org/details/s962id11784240



SECTION OF GRAIN OF WHEAT.

WELLCOME INSTITUTE LIBRARY
Coll. WelMOmec
Coll. No.

JOURNAL
OF THE
NEW YORK MICROSCOPICAL SOCIETY.

VOL. XIII. APRIL, 1897. No. 2.

CUTTING AND MOUNTING OF SECTIONS OF CEREAL GRAINS AND STARCHY TUBERS.

BY J. D. HYATT.

(*Read February 19th, 1897.*)

The reason for the present exposition is not the claim to the discovery of anything new in the methods adopted, but the remembrance of the difficulties which I have lately encountered, together with a consideration of the fact that, during my twenty years' membership in this Society, the American Microscopical Society, and the American Microscopical Postal Club, I have never yet seen, on exhibition, a section of wheat or other grain. While we have had before us sections of almost all conceivable organic and inorganic substances, it seems a little remarkable that a microscopical study of such great economic importance as that of the cereal grains should have been omitted. It is true that we find drawings and descriptions of such sections in our botanical works and agricultural reports, but we all know how such descriptions compare in interest with a view of the objects themselves.

My principal motive, however, in presenting these sections to you this evening is to illustrate the educational value of the microscope in our public schools. Dr. Julien, in his interest-

Description of Plate 63.

TRANSVERSE SECTION OF GRAIN OF WHEAT.

1.—Fruit coats : epidermis, mesocarp, and endocarp.
2.—Seed coats.
3.—Gluten cells, or perisperm.
4.—Starch cells, or endosperm.

ing and admirable address before this Society on "Microscopy in the Scheme of Education," has advocated in very forcible terms the value of the microscope in arresting the attention, and developing the observing and reflecting faculties of children. While I have seen the time when it might have been considered an unwarrantable innovation and encroachment upon the exclusive domain of "the three Rs" for a teacher, in one of the New York public schools, to bring a microscope into the class-room; yet, under the more intelligent administration of our present School Board, such a step may now not only be taken with impunity, but possibly be even regarded with favor.

In some of the schools in this city there has been established within the last few years a course of instruction in manual training, in which the boys, under teachers especially qualified, are instructed in designing and working various simple devices in wood, and the girls are taught sewing and cooking. In the last art it is wisely provided that the teacher shall not simply be a cook, but a person thoroughly skilled in such scientific and technical knowledge as may enable her to give intelligent instruction regarding the nature and nutritive value of the various articles used for food. She is also required, in the language of the school manual, to explain and make clear to the minds of her young students in cookery such (to them) abstruse subjects as the "Germ Theory, and the Causes of Decay and Decomposition in Organic Bodies."

By what process of instruction the teachers were expected to develop in the minds of pupils, from twelve to fourteen years of age, clear ideas of these subjects without the use of the microscope is quite incomprehensible. Such an instrument as the microscope has never been on the list of school supplies. Possibly it was supposed that these very young people could attain this scientific knowledge by the same process of intellectual development that has, in times gone by, been pursued in regard to all other subjects taught, and that is, by committing to memory the explanations to be found in properly prepared text-books.

An additional motive for presenting this subject is an occur-

rence in my own late experience. Happening to visit the cooking teacher's class in my school one day, I found her engaged in explaining to the pupils the relative nutritive value of the various kinds of flour, dependent upon different processes in milling the wheat. While the teacher's explanation was sufficiently lucid the difficulty of fully conveying her meaning to the minds of these young girls will be easily understood, when we reflect that, probably, not one in ten of our city girls has ever seen a kernel of wheat, or has the remotest conception how, or of what flour is made. In this instance while the pupils were outwardly exhibiting respectful attention, there was still an air of listlessness which indicated the wandering thought. The teacher quickly perceived this, and, interrupting her lecture, asked if I could furnish a section of the kernel of wheat, which, when placed under the microscope, might facilitate a proper understanding of the subject.

I agreed to furnish the section. But I discovered later that it is sometimes much easier to promise than to perform. I found no difficulty in cutting the section. But, after four or five days' trial, I learned that to mount it properly and permanently was one of the most difficult undertakings I had ever attempted in all my thirty years' experience in preparing microscopical objects. The persistent obstinacy with which the starch grains would, under every conceivable method of treatment, leave their cells, and flow into the mounting medium, surrounding and beclouding the section was the obstacle to be overcome.

It is to save a like expenditure of time to such of our members as may wish to prepare similar sections that I exhibit the final results of my labor. The mounts, though not entirely free from a few surrounding starch grains, are fairly satisfactory, as the slides on the stands will show. I am already more than repaid for all labor, however, by the great interest manifested by the pupils when these sections were examined by them under the microscope, and by the readiness with which they evidently comprehended all subsequent explanations of the "nutritive qualities of flour as developed by different processes of milling." Any child could easily compre-

hend, upon examining the sections, that flour, deprived of the nitrogenous matter contained in the gluten cells, so beautifully arranged around the white starchy interior, would lose its most nutritious element.

All the pupils were required to draw upon paper a figure of the section as it appeared to them under the microscope. This was fairly well done by nearly all at the first attempt. The only fault being in some cases a disproportionate exaggeration of the coats surrounding the interior starchy cells.

I have here reproduced one of the sections most correctly drawn by them, showing the contents of a kernel of wheat. It represents a transverse section magnified about thirty diameters. The extreme outer coat (Plate 63, 1) is the epiderm, or husk, and constitutes what in milling is called "the bran." It consists largely of cellulose, and contains no important nutritious element. The next layer (2), quite thin, contains some oil and albumen. The rectangular symmetrically arranged layer of cells (3) are filled with gluten. The entire interior (4) is filled with cells of irregular shape containing starch, and it is of this that the finest wheat flour is almost exclusively made. The more nutritious nitrogenous elements contained in the gluten cells are excluded in the milling, because these gluten cells, being of a darker color, would, if ground with the flour, impair the extreme whiteness, which, in the estimation of bakers and of most housekeepers, constitutes its chief value. Chemical analysis, however, shows that flour milled from the so-called "whole wheat," including layers 2 and 3, in which reside certain nitrogenous and other mineral elements, makes a bread much more nutritious and wholesome, though of a darker color, than that made from the fine wheat flour. In sections of wheat, rye, oats and Indian corn only a single row of gluten cells is seen. In barley there are three rows, but in this latter case the cells being smaller the quantity of gluten contained is not so greatly in excess as the number might indicate.

No especial difficulty is encountered, and no especial experience is required in making satisfactory sections of grains. The main precaution is to soften the kernels slightly, and not

too much, by immersion in water. If too soft, the starch will fall out of the cells. If too hard, the sections crumble under the knife. Indian corn may be kept moist for twenty-four hours; wheat four or five hours; rye five or six; barley ten or twelve, and oats not more than one or two hours. The difference in these grains, with regard to the length of time required to soften them, consists in the thickness or hardness of the outer or epidermal coat. This in Indian corn is hard, dry and oily, and therefore resists the action of water. In oats it is very thin and easily penetrated. Barley, having a very shallow groove, and being surrounded by a thick coat of gluten cells insoluble in water, resists softening for a long time. Imbedding may be done in any convenient manner, as the sections are easily cut when the grain is slightly softened. Perhaps paraffine is the best material for the purpose, as it holds the grain so firmly that it may be cut in any direction. No elaborate microtome is necessary. Any simple section cutting contrivance answers quite well. But care must be taken to have the knife as sharp as possible. The requisite thickness, or rather thinness of sections is a matter of some importance. The starch grains will all fall out if the sections are too thin, and the gluten cells will be disagreeably opaque if they are too thick. But as a great number of sections can be cut from a single grain, a selection can easily be made of such as appear of a proper degree of transparency.

Glycerine jelly is the best medium for mounting. This must be softened to the requisite degree of fluidity by placing it in a cup of warm water. The sections are best removed from the knife by a camel's-hair pencil. If they are deposited in a shallow dish of water they may be taken up with the pencil as wanted and placed upon the slide, the centre of which should be marked on the back with a dot of ink. If the slide is held inclined a drop of water placed above the section will run down and carry away nearly all the surrounding grains of starch. If any starch grains remain they may be removed with a small brush. Now, while holding the slide in a horizontal position, take a cover in the forceps, warm it slightly over a spirit lamp, and holding its exact centre over

the section lower it carefully upon the gelatine. If this is carefully done the cover will settle down to its place without disturbing the starch cells. Any attempt to move the cover or to press it down will cause a cloud of starch to issue from the cells. Should the gelatine become somewhat hardened before the cover is put on, so that it does not go down of its own weight, allow the gelatine to become quite hard, then place a slight weight on the cover and gently warm the slide over a lamp. The cover then will settle down to its place without disturbing the starch.

The most difficult sections to mount are those of oats and wheat, while little difficulty will be experienced with Indian corn, barley or rye. Sections of potato and other starchy tubers are easily mounted by following the foregoing directions. All attempts to fix the starch in its cells by any gum or cement, before or after cutting the sections, proved with me entirely futile.

THE BAUSCH AND LOMB FILAR MICROMETER.

BY P. H. DUDLEY, C. E.

(*Read March 19th, 1897.*)

This micrometer thoroughly fulfills its design in permitting the measurement of minute objects under the microscope with the highest degree of precision. Its equally important uses,

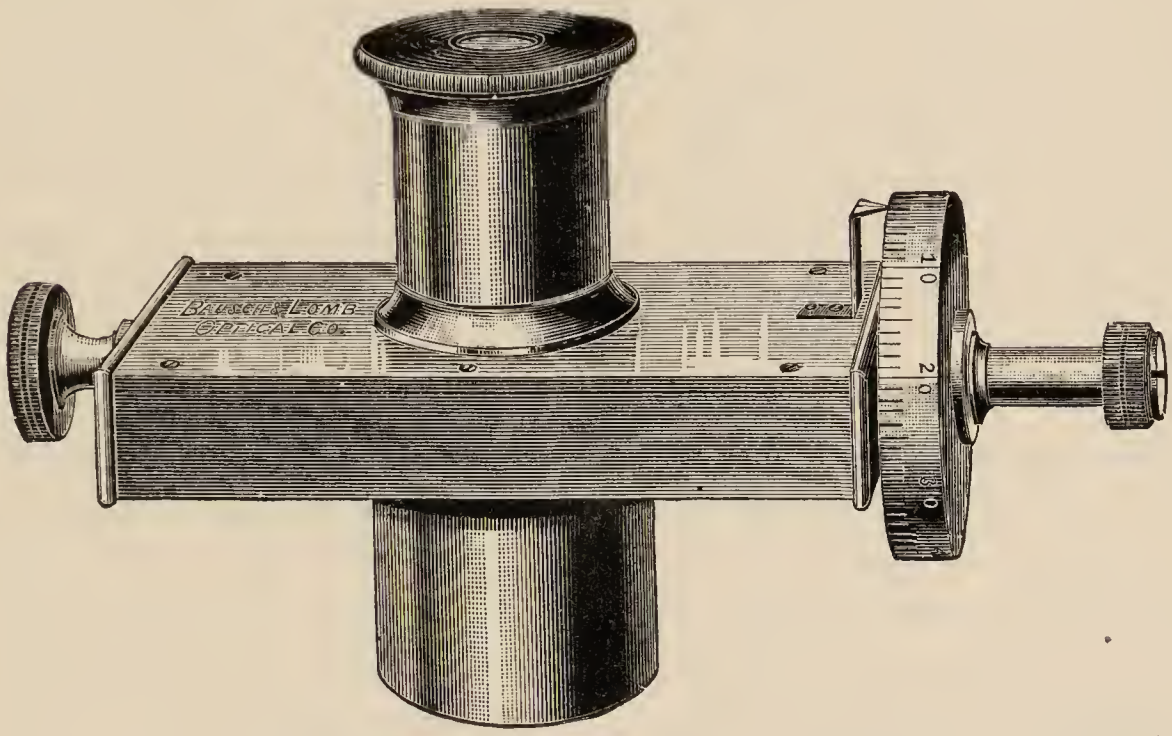


FIG. 1.—BAUSCH AND LOMB LARGE FILAR MICROMETER.

however, are comparisons of graduations on bars with those of reference standard bars, for physical and industrial purposes. The micrometer consists of an unusually large metal case, in which a rectangular frame carries a glass plate, on which are ruled two lines, one vertical and the other longitudinal, corresponding to the cobweb lines of the earlier micrometers.

FIG. 2.—FIELD OF BAUSCH AND LOMB MICROMETER SHOWING CROSS LINES AND RECORDING COMB.

The rectangular frame carrying the glass plate and ruled lines is moved by the micrometer screw. For reference there is a secondary vertical line ruled on another glass plate to which the indicating comb for each revolution of the micrometer screw is attached. This secondary vertical line is adjustable by a milled head screw on the end of the case opposite to the micrometer screw. In some of the earlier micrometers made by Messrs. Troughton and Simms the sec-

ondary vertical line also had a micrometer screw and graduated drum. The position of said line could be known in any part of the field, and the line could be set on an object the same as the other movable line.

In the present form of filar micrometer, to set the secondary or reference line, the graduated micrometer drum must be set to zero, and the reference line adjusted until both lines coincide, or cover the same object on the stage. The importance of a reference line for close comparisons can hardly be over-estimated. It can be set on some division of a graduated bar, or other object which is being compared, and, while using the micrometer screw and movable line for measurement, it can be noticed whether or not tremors of the instrument or expansions have disturbed the first setting, which frequently will be found to be the case.

The proposed micrometer lines shown in Fig. 3 could be made on glass plates, the vertical reference line and the vertical micrometer line each having a short blank space on one or both sides of the horizontal line. This plan would allow greater precision in bisecting lines on the stage or on other objects than is possible with full lines. The blank spaces on the reference and the micrometer lines should not exactly coincide, but should slightly overlap each other, so that the bisection of the reference line could be more exactly determined than with full lines.

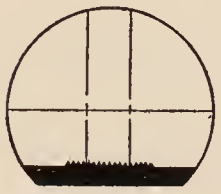


FIG. 3.—FIELD OF PROPOSED MICROMETER WITH INTERRUPTED LINES.

Another important advantage of the reference line is setting the two lines to a space on the stage micrometer, and then comparing the other spaces on the stage micrometer to see whether or not each one is of equal value, without the use of the micrometer screw, except for a small fraction of a turn. One is then able to investigate the equality of the graduations of the stage micrometer independently of the errors of the micrometer screw. To find whether or not the graduations are of proper length a comparison must be made with a standard stage micrometer in which the value of each division has been determined. Standard stage micrometers without slight errors of division have not yet been made and

put on the market. The error of each division must be ascertained when the highest precision is desired. The dividing engines of to-day are so much improved that the ordinary micrometers are sufficiently accurate for general purposes.

In the investigations of the errors in any instrument of precision it is desirable to take them up separately; *i. e.* to find the errors of the screw, and the errors of the stage micrometer independently of each other. In this micrometer the cross lines and the object are observed by means of a Ramsden positive eye-piece mounted on a sliding tube so that the lines may be sharply focussed; otherwise, parallax will occur on a slight movement of the eye, introducing errors. For the highest precision, and particularly when a number of comparisons are to be made from time to time, the eye-piece should screw into the tube and the collar should be graduated so that its position can be read and recorded. Any change in the height of the eye-piece alters the tube length, and consequently the magnification of the object.

It will be readily understood that the prime essentials of a micrometer of precision are: First,—Uniformity of the pitch of the screw, and absence of lost motion in the collar and nut; Second,—Graduation of the drum. It will also be subsequently shown that owing to the diffraction lines on the stage micrometer, the width and construction of the lines in the eye-piece micrometer, and the bisection of the stage micrometer lines are only approximations, and the errors may be greater from this source than from the imperfections of the short micrometer screws of recent construction.

A great deal of time and money have been spent by firms in this country and abroad to produce screws of precision, and now on some of the finest engine lathes screws can be cut of very great precision, and by subsequent grinding the periodic errors can be practically eliminated in screws of a few inches in length. The Bausch and Lomb Optical Co. state in their catalogue that the screw in this micrometer is made of either 0.5 millimeters, or $\frac{1}{50}$ of an inch pitch. The movement of the screw is indicated for a part of one revolution by the graduated drum, which is divided into 100 spaces and is attached

to the axis of the screw. Each complete revolution is read from the comb, and is equal to 0.5 of a millimeter or $\frac{1}{50}$ of an inch, and as the drum is divided into 100 spaces, each space is approximately equal to 0.005 of a millimeter or $\frac{1}{5000}$ of an inch. What the value of this movement will be on the measurement of an object depends upon the tube length and the objective used; therefore, the value of one space, or a complete revolution of the graduated drum must be ascertained by a comparison with the known measures of the stage micrometer, thus obtaining a factor to reduce all observations to definite measures. The movable cross line has a movement of 14 millimeters when measuring a large object on the stage with a low power, and this movement is reduced as the power of the objective is increased. By means of an adapter the micrometer can be used on any tube. A clamp screw holds the micrometer securely to the tube.

The micrometer was delivered to me in a box in which it stood in a vertical position, the lid pressing the eye-piece in when it was closed. I had a box made in which the micrometer will lie on its side for travelling, and retain the focus of the eye-piece as last used.

For rapid movements the micrometer screw is turned by the small milled head, but for slower and more accurate adjustment, a vulcanite disc connected to the graduated drum is provided, which enables the movements of the screw to be made with greater steadiness and accuracy than is possible with the small milled head. The movement of the rectangular frame carrying the cross lines in either forward or backward movement of the micrometer screw is without any apparent lost motion. The screws work against springs.

One of the stipulations as to the acceptance of this micrometer was that the screw should be one of precision, as to uniformity of pitch, and should also be free from periodic errors. It is not necessary to have a screw of standard length for the filar micrometer, as would be the case in a screw stage micrometer. In the filar micrometer, as already stated, the value of the divisions must be determined from a stage micrometer. To test the micrometer screw a good stage micrometer is

necessary, at least so far as equality of the spaces is concerned. I have several micrometers ruled on glass by Prof. W. A. Rogers twelve years ago on his first dividing engine. Some were on glass slips and others on glass covers. The material was not entirely suitable, but was the best that could be obtained at that time. The ruling was done with splinters of diamonds, and beside the centre line there is, as Prof. Rogers says, a slight rolling over of the glass on the edges of the lines, which was quite marked when first ruled, but which in time flaked off, leaving serrated edges to the lines. The lines were not filled or covered, and the fragments which have flaked off render all of the finest ruled micrometers of 1,000 to 10,000 lines per inch very indistinct at this date. One micrometer ruled to millimeters with one space ruled to hundredths of millimeters is in a fair state of preservation.

On my Ross stand, Tolles ¼ inch objective, the draw tube out, until the value of one revolution of the micrometer screw was ten microns, I obtained the following values of the spaces of the Rogers micrometer, as shown in Table 1.

TABLE 1.

No. of Space.	1st Reading. Microns.	2d Reading. Microns.	Mean of both Readings. Microns.	Mean value of Spaces. Microns.
1	10.1	10.1	10.10	10.10
2	20.0	20.0	20.00	9.90
3	30.0	30.0	30.00	10.00
4	40.0	40.0	40.00	10.00
5	50.0	50.1	50.05	10.05
6	60.0	60.0	60.00	9.95
7	70.0	70.0	70.00	10.00
8	80.1	80.0	80.05	10.05
9	90.0	90.0	90.00	9.95
10	100.1	100.1	100.10	10.10

It will be noticed that the apparent variations in the spaces are not greater than 0.05 of a micron except in each end space. Those are errors of observation to a large extent. The spaces in this micrometer are nearly uniform. Illumination: Electric light; Abbe condenser, 1.20 aperture.

Since the observations in Table 1 were made, they have been repeated under the same conditions with nearly identical results, showing that the errors of the screw, if there be any, are less than the tremors and errors of observation on the old model of the Ross stand. On one of Bausch & Lomb Optical Company's recent B.B. inexpensive continental stands the tremors are almost wholly eliminated.

Zeiss Stage Micrometer.—This is one of the ordinary micrometers found in the market and has been ruled probably two or three years. It is divided into millimeters, and one space into tenths of millimeters, and sells for about $2 here. The ruling is on a glass slip, the lines being filled and covered by a cover glass, allowing them to be used with homogeneous objectives. The filled lines are from 2.7 to 3 microns wide, and because they are so dark it is much more difficult to bisect them than the uncovered lines. The lines, however, will be much more durable. Compared on the same stand with the same length of draw tube and the Tolles ¼-inch objective, as already described for the Rogers micrometer, a mean of four measurements gave the following approximations for each one-tenth mm. space. It should be stated that for each one-tenth mm. the lines in the filar micrometer were fixed, the stage micrometer being moved by the mechanical stage. Illumination: electric light; Abbe condenser, 1.20 aperture.

Zeiss Stage Micrometer.

Table 2.		Table 3.		Table 4.	
No. of Space.	Observed Value in Microns.	No. of Space.	Observed Value in Microns.	No. of Space.	Observed Value in Microns.
1	100.00	1	100.00	1	100.50
2	100.00	2	100.13	2	100.00
3	100.10	3	100.32	3	100.20
4	100.30	4	100.32	4	100.70
5	99.70	5	99.52	5	99.50
6	99.70	6	99.54	6	100.00
7	101.70	7	101.28	7	100.99
8	100.00	8	99.56	8	99.70
10	99.75	10	99.58	10	99.80

For Table 2 the illumination of the lines was indistinct and their bisection uncertain. For Table 3 five measurements were made by reflected white cloud light; the illumination of the lines being much better. But the inexact bisection of the lines is still a large source of error in the observations when the highest precision is desired. This feature can doubtless be rendered more exact by a modification in the form of the cross lines in the filar micrometer, which will be considered in a subsequent paper. The errors of observation are, however, not sufficiently great to remove doubt as to the slight difference of value of the spaces in the stage micrometer.

I made a series of ten observations on this stage micrometer with Prof. W. A. Woodward's filar micrometer and microscope, using a one-inch objective, the results being given in Table 4. Only five of the spaces could be compared at one time. This filar micrometer carries three vertical cobwebs of increasing width, instead of lines ruled on glass. Either cobweb can be used at pleasure. In the table I have combined the errors of magnification, the possible errors of the screw, and those of observation. One feature, which will be noticed in comparison with the other tables, is that the first and sixth spaces have large errors of magnification. The fifth and tenth spaces are also affected, in a much less degree.

TABLE 5. Giving the progressive readings on comb and graduated drum of the micrometer screw of ten series of observations on the one-hundredth mm. spaces of the Rogers stage micrometer. Bausch & Lomb Optical Co. B. B. Continental Stand; draw tube out full length; Tolles 1/4-inch Objective; White Cloud illumination; Abbe Condenser, 1.20 aperture. Each space on the drum is equal to 0.6 of a micron.

NO. OF SERIES OF OBS.	INDEX.	1ST SPACE.	DIFF.	2D SPACE.	DIFF.	3D SPACE.	DIFF.	4TH SPACE.	DIFF.	5TH SPACE.	DIFF.	6TH SPACE.	DIFF.	7TH SPACE.	DIFF.	8TH SPACE.	DIFF.	9TH SPACE.	DIFF.	10TH SPACE.	DIFF.
1	0	62.0	62.0	124	62.0	186	62.0	250	64.0	313	63.0	376	63.0	439	63.0	502	63.0	564	62.0	625	61.0
2	0	63.0	63.0	124	61.0	186	62.0	249	63.0	312	63.0	375	63.0	438	63.0	501	63.0	564	63.0	625	61.0
3	0	62.5	62.5	125	62.5	188	63.0	249	61.0	313	64.0	375	62.0	438	63.0	502	64.0	562	60.0	625	63.0
4	0	62.0	62.0	123	61.0	187	64.0	249	62.0	312	63.0	375	63.0	438	63.0	500	62.0	563	63.0	625	62.0
5	0	62.0	62.0	125	63.0	187	62.0	249	62.0	312	63.0	375	63.0	438	63.0	501	63.0	564	63.0	625	61.0
6	0	62.0	62.0	123	61.0	186	63.0	248	62.0	312	64.0	374	62.0	438	64.0	501	63.0	564	63.0	625	61.0
7	0	62.0	62.0	124	62.0	187	63.0	250	63.0	313	63.0	375	62.0	438	63.0	502	64.0	564	62.0	626	62.0
8	0	62.0	62.0	123	61.0	187	64.0	250	63.0	313	63.0	375	62.0	439	64.0	501	62.0	564	63.0	626	62.0
9	0	62.0	62.0	124	62.0	187	63.0	250	63.0	313	63.0	376	63.0	440	64.0	501	61.0	564	63.0	627	63.0
10	0	62.0	62.0	124	62.0	187	63.0	250	63.0	313	63.0	375	62.0	438	63.0	501	63.0	564	63.0	626	62.0
Total	per Space.....		621.5		617.5		629.0		626.0		630.0		625.0		633.0		628.0		625.0		618.0
Average	"	"	62.15		61.75		62.9		62.6		63.0		62.5		63.3		62.8		62.5		61.8

The average results clearly show the zones of unequal magnification for the objective and illumination.

In presenting these figures I only wish them considered as rough approximations; the known errors being too great to treat the results by the method of least squares.

(*To be continued.*)

CLASSIFICATION OF SANDS AND SILTS.

BY ALEXIS A. JULIEN, PH.D.

(*Read March 5th, 1897.*)

Under the general term, *sand*, we may properly include every loosely granular form of matter in nature, ranging in size from the coarser varieties, to which we apply the terms, meteorites, boulders, volcanic bombs, gravel, etc., down to the finest kinds of silt. There are but a few attempts on record toward a broad classification of this vast variety of materials. One of the earliest of these was that of the great French geologist, Daubrée, in 1857, founded on the genetic forces to which sands owe their derivation.

Classification of Sands,

by genesis (A. Daubrée).

DETRITAL.

Sands formed by granitic trituration by waves.

Sands produced by trituration under pressure of glaciers.

Sands derived from disintegration, in place, of granitic and other quartzose rocks.

CHEMICAL.

Crystallized sands.

Globuliferous sands (chalcedony, oolitic iron and calcareous pisolite).

MECHANICAL.

Water-worn sands.

This method is unsatisfactory, not only from the insufficient distinction of Detrital and Mechanical sands, but from the entire disregard of important varieties of cosmical, meteoric, volcanic and organic origin. A little later, in 1866, the German lithologist, Zirkel, presented a mode of classification, then in vogue, founded upon both the size and the form of the grains.

Classification of Sands,

by size and form (F. Zirkel).

	SIZE.	FORM.
Pearl-sand or gravel	1½ lines	Grains often pearl-like, also including many angular.
Coarse sand	¾ line	
Fine sand, spring-sand, grinding sand, drift-sand	hardly ¼ line	Granules generally rounded.
Dust-sand or quick sand		Powder or dust-like particles, easily borne by the wind; the sand of dunes and deserts.

This method, as well as that of Sorby, in 1879, was directed only or mainly toward the siliceous or so-called quartz-sands which predominated on the European coasts.

Classifcation of Sands,

by form (H. C. Sorby).

1. Normal, angular, fresh formed grains, derived almost directly from granitic or schistose rocks.

2. Well-worn, rounded grains, with original angles completely lost, and surface looking like fine ground glass.

3. Mechanically broken into sharp, angular chips, showing glassy fracture.

4. Grains chemically corroded, with peculiar texture of surface.

5. Grains with perfect crystalline outline.

Without attempting here to present an exhaustive review of the subject, I would offer simply two methods of classification of sands and silts.

For purposes of a practical and technical character, such as soil-analyses in Agricultural Chemistry, examination of river-sediments in engineering operations, and sand-analyses for filtration-beds by the sanitary engineer, various systems of classification of sands and silts have been proposed, founded on the sorting by passage through a series of sieves, usually of wire-mesh. These I have found objectionable, both on

account of the irregularity of their rectangular apertures and on account of the detention of angular silt-particles between the crossing wires. The approximately circular apertures, in sieves consisting of thin perforated plates, yield more uniform results, in closer relation to that important dimension of a sand-grain, breadth, which A. C. Hazen has shown to approximate the mean of the two other dimensions, length and thickness.

With the use of the well-known French "gem sieves," the sorting of a large number of samples of sediments has led me to propose the following classification. It will be seen, by comparison of the second and third columns, that no safe reliance can be placed upon the figures of denomination which reach us as marked upon the finer of these sieves. The figures of the second column have been obtained by actual measurement, under the microscope, of breadth, upon a large number of the sand-grains left upon each sieve.

Classification of Sediments,

by breadth (in millimeters).

	NAME.	BREADTH.	MODE OF SORTING.
A.	Very coarse gravel	10 and over.	By gem sieve, "10."
B.	Coarse gravel	5.0–9.99	By gem sieve, "5."
C.	Medium gravel	3.0–4.99	By gem-sieve, "3.5."
D.	Fine gravel	2.5–2.99	By gem-sieve, "2.5."
E.	Very coarse sand	1.85–2.49	By gem-sieve, "1.8."
F.	Coarse sand	1.05–1.84	By gem-sieve, "1.0."
G.	Medium sand	.55–1.04	By gem-sieve, "0.5.'
H.	Fine sand	.35– .54	By gem-sieve, "0.4.
I.	Very fine sand	.29– .34	By gem-sieve, "0.3."
J.	Very coarse silt	.24– .28	By gem-sieve, "0.2."
K.	Coarse silt	.20– .23	By gem-sieve, "0.1."
L.	Medium silt	.12– .19	Left on fine silk bolting-cloth.
M.	Fine silt	0.5– .11	Passed through bolting-cloth.
N.	Very fine silt	0.5 and less.	By suspension in water.

The comparative and sufficient accuracy obtained by this apparatus may be illustrated by the following duplicate analyses of a sample of sand.

Analysis of Beach-Sand,

Belmar, N. J.

	MM.	PER CENT.	
E. Very coarse sand	1.85–2.49	.10	.04
F. Coarse sand	1.05–1.84	1.35	1.63
G. Medium sand	.55–1.04	52.69	51.94
H. Fine sand	.35– .54	42.90	38.33
I. Very fine sand	.29– .34		5.10
J. Very coarse silt	.24– .28	2.65	2.00
K. Coarse silt	.20– .23		.70
L. Medium silt	.12– .19	.30	.24
M-N. Finer silt	.11 and less.	.01	.02
		100.	100.

The second and more general classification of gravels, sands and silts, which I would propose, is presented below. It is based on those natural agencies concerned in the initial development of sand and as vehicles for its transportation, sculpture and concentration. As man is one of the most active and efficient agents engaged in the manufacture of sands on the Earth's surface, the last division is devoted to the varieties of artificial sands.

Classification of Gravels, Sands and Silts.

I.—*Disintegral.*

A. *Primary.*

1. Crush-sands (and friction-breccias).
2. Decayed rock-gravels and sands.
3. Primary residual earths and soils.
4. Glacier-gravels, sands and clays (*till*).
5. Regenerated sands, from decayed sedimentaries (desert-sands, in part).

B. *Secondary.*

6. Secondary residual earths and soils (with crystal-sands and oolitic earths).
7. Extruded gravels, sands and muds.

II.—*Meteoric.*

8. Aerolites and cosmical dust.
9. Water-sands (oolitic and crystal), including rain-drops, hailstones, snow-flakes, etc.

10. Volcanic bombs, sands and ashes.
11. Atmospheric shower-sands and dusts (organic, in part).
12. Æolian desert-sands.
13. Æolian dust (*loess*, in part).

III.—*Fluviatile.*

14. Detrital brook and river sands and gravels (quicksands, in part).
15. River concentrated sands.
16. River-silts and delta-deposits.
17. Glacial silts.
18. Ancient river-gravels, sands and silts (*loess*, in part.)
19. Æolian river-sands.

IV.—*Lacustrine.*

A. *Shore deposits.*

20. Detrital lake beach-sands and shingle.
21. Lake concentrated sands.
22. Æolian lake-sands (dune-sands, in part).

B. *Bottom deposits.*

23. Lake-bottom gravels, sands, silts and earths(including organic oolitic sands).
24. Ancient lake-bottom gravels, sands, silts and clays.

V.—*Marine.*

A. *Shore deposits.*

25. Detrital sea-beach sands and shingle (quicksands, in part).
26. Marine concentrated sands.
27. Æolian marine dune-sands.

B. *Bottom deposits.*

28. Sea-bottom gravels, sands, silts and muds (*glauconite*, in part).
29. Marine oolitic and quicksands.
30. Ancient sea-bottom gravels, sands, silts and clays (*glauconite*, *oolitic iron*, *pisolite*, etc.).
31. Deep-sea silts, clays and abyssal ooze.

VI.—*Artificial.*

32. Crystallized and granulated products.
33. Powders of abrasion, trituration and grinding.
34. Sublimates.

THE COLOR AND COLOR-PATTERNS OF MOTHS AND BUTTERFLIES.—Alfred Goldsborough Mayer, in his publication on this subject (Proceedings of the Boston Society of Natural History, Vol. XXVII., pp. 243–330, March, 1897), gives these items:

"We follow Poulton ('90) in dividing Lepidopterous colors into (1) pigmental and (2) structural.

"(1) Pigmental colors are due to the presence of an actual pigment within the scales, and although such colors are very common in the Lepidoptera, it is frequently very difficult to say off-hand whether a given color is due to a pigment or to some structural effect. Coste ('90–'91) and Urech ('93) have, however, given criteria for determining whether a color is due to a pigment or to some other cause. They succeeded, for example, in dissolving out the color in many cases, leaving the wing white or colorless. Coste used as solvents a number of strong acids and alkalis; while Urech confined himself to the use of water, hydrochloric acid and nitric acid. Their results may be conveniently summarized as follows:

"Black according to Urech is a pigmental color, for it may be dissolved out of the wings by means of hydrochloric or nitric acid.

"Brown is usually insoluble in water, but is soluble in hydrochloric or nitric acid.

"The red and orange pigments of the Pieridæ, Lycænidæ, Nymphalidæ, Zyganidæ, and some Papilios are soluble in water. They are insoluble in water in the Sphingidæ, Arctidæ, Bombycidæ, Saturnidæ, and Geometridæ.

"Yellow pigment is acted upon by reagents in almost the same way as the red and orange, especially if both red and yellow appear upon the same wing. It is soluble in the Pieridæ, Lycænidæ, Satyridæ, and some Papilios, but insoluble in the Sphingidæ, Arctidæ, Geometridæ, and a few Noctuidæ.

"White is usually a structural color, but can be dissolved out from the wings of the Pieridæ by water, being in this case, of course, due to a pigment.

"Green pigment can be dissolved out by water in the cases

of the Pieridæ, Lycænidæ, and Geometridæ. In the vast majority of cases, however, it is a structural color.

"Violet and blue are almost always due to structural causes. In a few cases, however, as in *Smerinthus ocellatus*, a blue pigment can be dissolved out.

"We see, then, that black, brown, red, orange, and yellow are usually due to pigment, while white, green, violet and blue are generally due to structural effects.

"It is well known that the scales of Lepidoptera are essentially hollow, flattened sacs often inclosing pigment, and Burmeister ('78) arrives at the conclusion, from the study of the scales in various species of *Castnia*, that the pigment is for the most part attached to the upper layer of the scale-sac, rendering it opaque, while the lower layer receives less pigment and is, in consequence, a little more transcluent.

"(2) Structural colors owe their origin to the external structure of the scales or wing-membranes and not to the presence of a pigment. They are often caused by diffraction, due to the scales being covered with fine, parallel striæ. Some of the most splendid colors in the animal kingdom are due to this cause; such are the iridescent and opalescent hues of many of the Morphos and Indo-Asiatic Papilios. Very often the scales which display such brilliant colors contain no pigment whatsoever; for if one will merely soak them in alcohol, ether, or water, all color disappears, and the scales become as transparent as glass. This test was devised by Dimmock ('83), who used it upon the brilliantly colored scales of many beetles. It was first discovered by Burgess ('80), and has since been confirmed by Kellog ('94), that the striæ which produce these structural colors are all upon the outer surface of the scale, *i. e.*, the surface which is away from the wing-membrane and exposed to the light. Kellog ('94) has determined the distance apart of the striæ upon the scales of many species of Lepidoptera. It appears, for example, that the striæ upon the scales of *Danais plexippus* are 2 μ apart, those upon the transparent scales of *Morpho* 0.72 μ, and upon *Callidryas eubule* 0.9 μ apart. It is very evident, then, that the brilliant coloration of the scales may be due to this fine striation, for

the fine striation upon Rowland's or Rutherfurd's finest gratings are approximately 1.5 μ apart, which is about the average distance between the ridges of the scales.

"Structural colors are, however, not always due to diffraction; in the case of white, for example, the color is almost invariably due to a reflection of all, or nearly all, the light that impinges upon the scales. As long ago as 1855 Leydig pointed out that the silvery white color seen in the scales of some spiders, such as *Salticus* and *Tegenaria*, was due to air contained within them; and more recently Dimmock ('83) has shown that silvery white and milk-white colorations are due to optical effects produced by reflected light. In the silvery white scales, however, such as those of the under surface of the hind wings of *Argynnis*, there must be a polished reflecting surface toward the observer, for both silvery and milk-white colors appear simply milk-white by reflected light.

"(3) Combination colors owe their richness and brilliancy to a combination of structural and pigmental effects. The geranium-red spots on the hind wings of the Mexican *Papilio zeunis* Lucas owe their red color to pigment, but over this red there plays, in certain lights, a beautiful pearly iridescence, which, in combination with the red, greatly enhances its charm. Urech ('92) has demonstrated that in the Vanessas there are scales which have chemical coloring matter and interference colors also. In addition he points out the interesting case of certain Lycænidæ where the scales exhibit to the eye only interference effects, and yet a pigment can be dissolved out of them by the use of water."

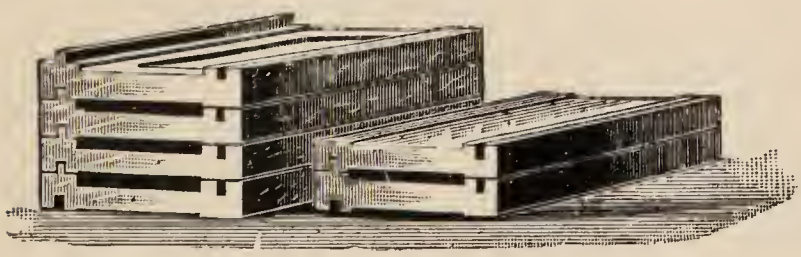


FIG. 1.

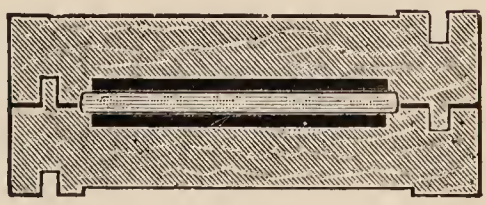


FIG. 2.

BAUSCH AND LOMB REVERSIBLE MAILING CASES.—We call attention to these mailing cases for microscopical slides. All the pieces are similar and interchangeable, avoiding the use

of "tops" and "bottoms." An ample depression in the face of each piece allows the stowing of a slide with a large cover, while avoiding the risk of the cover touching wood. Any number of slides and cases may be adjusted and piled one above the other, or one single slide may be securely held by simply reversing one piece of wood (Fig. 1). The median transverse section (Fig. 2) shows the relation of the pieces to the slide. For convenience, effectiveness, and inexpensiveness these cases are unsurpassed.

PROCEEDINGS.

Meeting of January 8th, 1897.

The President, Dr. Edw. G. Love, in the chair.

Sixteen persons present.

This being the stated time for the annual election of officers of the Society, Messrs. F. W. Leggett and George H. Blake were appointed tellers of the election.

Annual reports were received from the Treasurer, Curator, Recording Secretary, and Committee on Publications.

OBJECTS EXHIBITED.

1. Sections of head of the beetle, *Melandrya striata:* by L. Riederer.

2. Undetermined aquatic oganisms from Pyramid Lake, Adirondack Mts., N. Y.: by L. Riederer.

3. Transverse section of grain of wheat: by J. D. Hyatt.

4. Transverse section of grain of Indiana corn: by J. D. Hyatt.

5. Scale insects from orange fruit: by F. W. Leggett.

6. Larva of the "Book-worm," *Sitodrepa panicea*: by Edw. G. Love.

On the closing of the polls the following persons were declared elected officers of the Society for the year 1897:

President, Frank D. Skeel.
Vice-President, George W. Kosmak.
Treasurer, James Walker.
Recording Secretary, George E. Ashby.
Corresponding Secretary, J. L. Zabriskie.
Librarian, Ludwig Riederer.
Curator, George E. Ashby.
Auditors, { F. W. Devoe, F. W. Leggett, H. C. Bennett.

Meeting of January 15th, 1897.

The President, Dr. Frank D. Skeel, in the chair.

Thirty-five persons present.

Dr. Edw. G. Love, the retiring President, delivered the annual address, entitled "The Use of Polarized Light in Microscopy."

This address referred to the following subjects, and was illustrated by diagrams, material and apparatus as follows:

Reflection and single refraction of light. Index of refraction. (Diagrams.)

The polarization of light in nature.

Light polarized by reflection. Polarizer and analyzer. Angle of polarization. (Norremberg's and other reflecting polarizers. Diagrams.)

Polarization by single refraction. (Diagrams and a bundle of plates.)

The undulatory theory. (Card models and diagrams.)

Polarization by double refraction. (Diagrams, Iceland spar, tourmalines, animal and vegetable substances.) Optic axes. Uniaxial and biaxial crystals. Positive and negative crystals. Methods for eliminating either the ordinary or extraordinary ray. Prisms of Nicol, Foucault and Rochon. (Diagrams and prisms.)

Interference of light. (Diagrams. Apparatus showing Newton's rings with ordinary and monochromatic light. The butterflies, *Morpho cypris*, and *M. sulkowskyi*, iridescent glass, etc.)

Chromatic polarization. Thin films. (Diagrams and card models. Various objects made of films of selenite and mica. Wedge of selenite showing bands. Slides showing different colors produced, when selenite films of the same thickness are superposed parallel and at right angles.)

Effect of substances under tension on polarized light. (Glass under compression. Unannealed glass of several forms.)

Meeting of February 5th, 1897.

The President, Dr. Frank D. Skeel, in the chair.

Twenty-three persons present.

Mr. George W. Kosmak having declined acceptance of the Vice-Presidency to which he was lately elected, the following were appointed committee on nomination of Vice-President: J. L. Zabriskie, Dr. H. A. Parmentier, James Walker.

The Corresponding Secretary presented a communication from Mr. K. M. Cunningham of Mobile, Alabama, entitled "A New Marine Fossil Diatomaceous Deposit in Alabama." This paper was aceompanied by specimens of the material described, donated to the cabinet of the Society and for distribution among the members, and is published in this volume of the Journal, p. 6.

The thanks of the Society were tendered Mr. Cuuningham for the communication and the donation.

OBJECTS EXHIBITED.

1. Section of stalactic Wavellite from White Horse Station, Chester Co., Pa., polarized: by James Walker.

2. Section through anterior portion of human eye: by Frank D. Skeel.

3. Section of eye of human embryo. Retina not yet unfolded: by Herbert Neher.

4. Longitudinal section of body of Centipede: by George E. Ashby for Charles P. Abbey.

5. Longitudinal section of head of Chameleon: by George E. Ashby for Charles P. Abbey.

Dr. Skeel gave an interesting description of the structure of the human eye, illustrated by black-board diagrams. Dr. Neher also explained his exhibit with the use of the black-board.

Meeting of February 19th, 1897.

The President, Dr. Frank D. Skeel, in the chair.

Thirty-seven persons present.

The President was elected a member of the Committee on Publications.

The chair appointed Mr. George W. Kosmak and Dr. Herbert Neher tellers of election of Vice-President, and at the closing of the polls Mr. F. W. Leggett was declared elected to fill that office for the year 1897.

Mr. J. D. Hyatt read a paper, entitled "Cutting and Mounting Sections of Cereal Grains and Starchy Tubers." Mr. Hyatt was assisted by two young pupils of School No. 85, Misses A. Lowry and M. Brockman, who in most able and interesting manner drew upon the black-board and explained diagramatic sections of grains of wheat and barley. The paper was also illustrated by sections under the microscope as noted below, and is published in this number of the JOURNAL, p. 19.

OBJECTS EXHIBITED.

1. Transverse section of grain of Wheat: by J. D. HYATT.
2. Do. of Barley: by J. D. HYATT.
3. Do. of Rye: by J. D. HYATT.
4. Do. of Oat: by J. D. HYATT.
5. Section of Fatty Tissue (Adipose): by HERBERT NEHER.

Dr. Neher gave a full explanation of his exhibit, illustrated by black-board diagrams.

The thanks of the Society were tendered the young ladies who had so ably assisted Mr. Hyatt in the elucidation of his subject.

MEETING OF MARCH 5TH, 1897.

The President, Dr. Frank D. Skeel, in the chair.

Twenty-two persons present.

Ernest Joseph Lederle, Ph.D., and R. C. M. Page, M.D., were elected resident members of the Society.

The Recording Secretary read a communication from Prof. James F. Kemp, Recording Secretary of the New York Academy of Sciences, inviting the Society to meet the sections of Mineralogy and Geology of the Academy to witness

an exhibition of polarization with the arc light by Prof. Van Dyke of Rutgers College, New Brunswick, N. J., at some time to be arranged in the future. The invitation was duly and thankfully accepted.

The Recording Secretary also read a communication from the Secretary of the Scientific Alliance of New York inviting this Society to nominate competitors for the prize to be awarded under the "Newbury Fund." The matter was referred to the Board of Managers.

Dr. Alexis A. Julien addressed the Society on "Classification of Sands."

The address was illustrated by a large diagram containing the specified divisions of the subject, by a specimen pebble sculptured by wind-driven sand, from the desert of Arabia Petrea, and by objects under microscopes as indicated below, and is published in this number of the JOURNAL, p. 34.

OBJECTS EXHIBITED.

Illustrations of the Classification of Sands: by ALEXIS A. JULIEN.

1. Silicified Foraminifera.

2. Meteoric spherule, Magnetic Iron Oxide. From beach sand, Bermuda.

3. Agate and Olivine. Beach sand, Nühan, Hawaii.

4. Grains of lava, Olivine, etc. Volcanic sand, Kanai, Hawaii.

5. Ancient sand-sphere (quartz). Beach sand, Rockaway, N. Y.

6. Feldspathic sand (thin section). Beach at Manchester, Mass.

7. Holothurian spicules. Beach sand, Bermuda, W. I.

8. Albite crystals from ancient concentrated river sands (polarized). Glen Alpine, Burke Co., N. C.

9. Moss-agate. Desert sand, Arabia Petrea.

10. Octahedron of Xenotine. Ancient concentrated river sands, Gum Branch, McDowell Co., N. C.

MEETING OF MARCH 19TH, 1897.

The President, Dr. Frank D. Skeel, in the chair.

Fourteen persons present.

Notice being given by the Recording Secretary that the evening of April 23d is the time appointed for the joint meeting of the Sections of Mineralogy and Geology of the New York Academy of Sciences, on motion it was resolved: That the rules be suspended, and that the invitation tendered this Society on the 5th inst. to participate in such joint meeting be accepted for the proposed date, April 23d.

Mr. P. H. Dudley read a description of the mechanism and operation of his exhibit, "The Bausch & Lomb Filar Micrometer," which description is published in this number of the JOURNAL, p. 25.

OBJECTS EXHIBITED.

1. Bausch & Lomb Filar Micrometer: by P. H. DUDLEY.
2. Rogers Stage Micrometer: by P. H. DUDLEY.
3. Zeiss Stage Micrometer: by P. H. DUDLEY.
4. Rogers Stage Micrometer, ruled on speculum metal, illuminated by Beck's vertical illuminator: by CHARLES S. SHULTZ.
5. Leitz Filar Micrometer: by CHARLES S. SHULTZ.
6. Bausch & Lomb Eye-piece Micrometer: by HERBERT NEHER.
7. Pollen of Tiger Lily: by HERBERT NEHER.
8. Section of Agate containing spherical crystallizations of iron pyrites: by J. D. HYATT.

PUBLICATIONS RECEIVED.

American Monthly Microscopical Journal: Vol. XVII., No. 10–Vol. XVIII., No. 2 (October, 1896–February, 1897).

The Microscope: Vol. IV., No. 10–Vol. V., No. 2 (October, 1896–February, 1897).

Bulletin of the Torrey Botanical Club: Vol. XXIII., No. 10–Vol. XXIV., No. 2 (October, 1896–February, 1897).

Bulletin of the New York Botanical Garden: Vol. I., No. 2 (January, 1897).

Psyche: Vol. VII., Nos. 247, 248 (November, December, 1896).

Anthony's Photographic Bulletin: Vol. XXVII., No. 11–Vol. XXVIII., No. 4 (November, 1896–April, 1897).

School of Mines Quarterly: Vol. XVIII., Nos. 1, 2 (November, 1896–January, 1897).

Natural Science Association of Staten Island. Proceedings: Vol. V., No. 10–Vol. VI., No. 5 (October, 1896–March, 1897).

Journal of the Franklin Institute: Vol. CXLII., No. 851–Vol. CXLIII., No. 855 (November, 1896–March, 1897).

Minnesota Botanical Studies: Bulletin No. 9 (November, 1896).

United States Geological Survey. "Mineral Resources": 15th Annual Report (1893); 16th Annual Report (1894–1895).

New York State Entomologist. 11th Annual Report (1896).

Museum of Comparative Zoology. Bulletins: Vol. XXVIII., No. 2–Vol. XXX., No. 3 (October, November, 1896). Annual Report (1896).

Academy of Natural Sciences of Philadelphia. Proceedings (1866).

Boston Society of Natural History. Proceedings: Vol. XXVII., pp. 75–330 (June, 1896–March, 1897).

American Academy of Arts and Sciences, Boston. Proceedings: Vol. XXXI. (1896), Vol. XXXII., Nos. 1–9 (November, 1896–January, 1897).

Chicago Academy of Sciences. 39th Annual Report (1896).

Cincinnati Society of Natural History. Journal: Vol XIX., No. 2 (March, 1897).

Field Columbian Museum. Publications: Nos. 12–15 (June–December, 1896).

Essex Institute. Bulletin: Vol. XXVI., No. 7–Vol. XXVII., No. 6 (July, 1894–June, 1895).

Cornell University Agricultural Experiment Station. Bulletin: Nos. 122–125 (December, 1896–February, 1897).

Michigan Agricultural Experiment Station. Bulletin: Nos. 136–140 (November, December, 1896).

Alabama Agricultural Experiment Station. Bulletin: Nos. 73–78 (October, 1896–February, 1897).

State University of Iowa. Bulletin Laboratory of Natural History: Vol. IV., No. 1 (December, 1896).

Colorado Scientific Society. Proceedings (February, 1896–February, 1897).

Historical and Scientific Society of Manitoba. Annual Report (1895). Worthies of Old Red River (1896).

Canadian Record of Science: Vol. VII., Nos. 1–3 (1896).

Ottawa Naturalist: Vol. X., Nos. 7–11 (October, 1896–February, 1897).

Journal of the Hamilton Association: No. 12 (1896).

Journal of the Royal Microscopical Society: 1896, Part 5; 1897, Part 1.

International Journal of Microscopy and Natural Science: Vol. VI., Part 32; Vol. VII., Part 33 (October, 1896–January, 1897).

Journal of the Quekett Microscopical Club: Vol. VI., No. 39 (November, 1896).

The Naturalist: Nos. 256–260 (November, 1896–March, 1897).

Bristol Naturalists' Society. Proceedings: Vol. VIII., Part 1 (1896).

North Staffordshire Naturalists' Field Club. Transactions: Vol. XXX. (1896).

Royal Society of New South Wales. Journal: Vol. XXIX. (1895).

Royal Society of South Australia. Transactions: Vol. XX., Part 2 (December, 1896).

The Victorian Naturalist: Vol. XIII., Nos. 5–10 (August, 1896–January, 1897).

Records of the Australian Museum: Vol. III., No. 1 (January, 1897).

Bulletin de la Société Belge de Microscopie: Vol. XXII., No. 10—Vol. XXIII., No. 3 (1896–97).

Bulletin de la Société Royale de Botanique de Belgique: Vol. XXXV. (1896).

Bulletin de la Société les Amis des Sciences et Arts de Rochechouart: Vol. V., No. 6—Vol. VI., No. 3 (1896).

Société des Sciences Naturelles et Archèologiques de la Creuse. Memoires: Vol. IV. (1896).

Société d'Etude des Sciences Naturelles de Béziers: Vol. XVIII (1895).

La Feuille des Jeunes Naturalistes: Nos. 313–317 (November, 1896–March, 1897).

Wissenschaftlicher Club in Wien. Monatsblatter: Vol XVIII., Nos. 1–5 (October, 1896–February, 1897). Jahresbericht (1896).

Nassauischer Verein für Naturkunde. Jahrbuch: Vol. XLIX. (1896).

Naturhistorische Gesellschaft zu Nürnberg. Abhandlungen: Vol. X., No. 4 (1896).

Gesellschaft zur Beförderung der gesammten Naturwissenschaften zu Marburg. Sitzungsberichte (1894–95).

Naturwissenschaftlicher Verein in Augsburg. Bericht: Vol. XXXII. (1896).

Brooklyn Medical Journal: Vol. X., No. 11—Vol. XI., No. 4 (November, 1896–April, 1897).

Pacific Medical Journal: Vol. XXXIX., No. 11—Vol. XL., No. 2 (November, 1896–February, 1897).

National Druggist: Vol. XXVI., No. 11—Vol. XXVII., No. 3 (November, 1896–March, 1897).

Meyer Brothers Druggist: Vol. XVII., No. 6—Vol. XVIII., No. 3 (June, 1896–March, 1897).

Johns Hopkins University Circulars: Vol. XVI., No. 128 (February, 1897).

Photographic Reproductions of Fungi. C. G. Lloyd. Issues Nos. 13, 14 (1897).

Académie d'Hippone. Comptes-Rendus (March, 1896).

Publications on Ants and Bees. Charles Janet (1896).

Bulletin de la Société Imperiale des Naturalistes de Moscou: 1896, No. 1.

Museo Nacional de Montevideo. Anales: Vol. VII., pp. 1–68 (1896).

Sociedad Científica "Antonio Alzate" Memorias: Vol. VIII., Nos. 9–12 (1895)--Vol. IX., Nos. 11, 12 (1896).

Scientific Society of Chile. Reports: Vol. II. (1892)—Vol. VI. (1896).

Revista Chilena de Hijiene: Vol. II., Nos. 7–9 (1896).

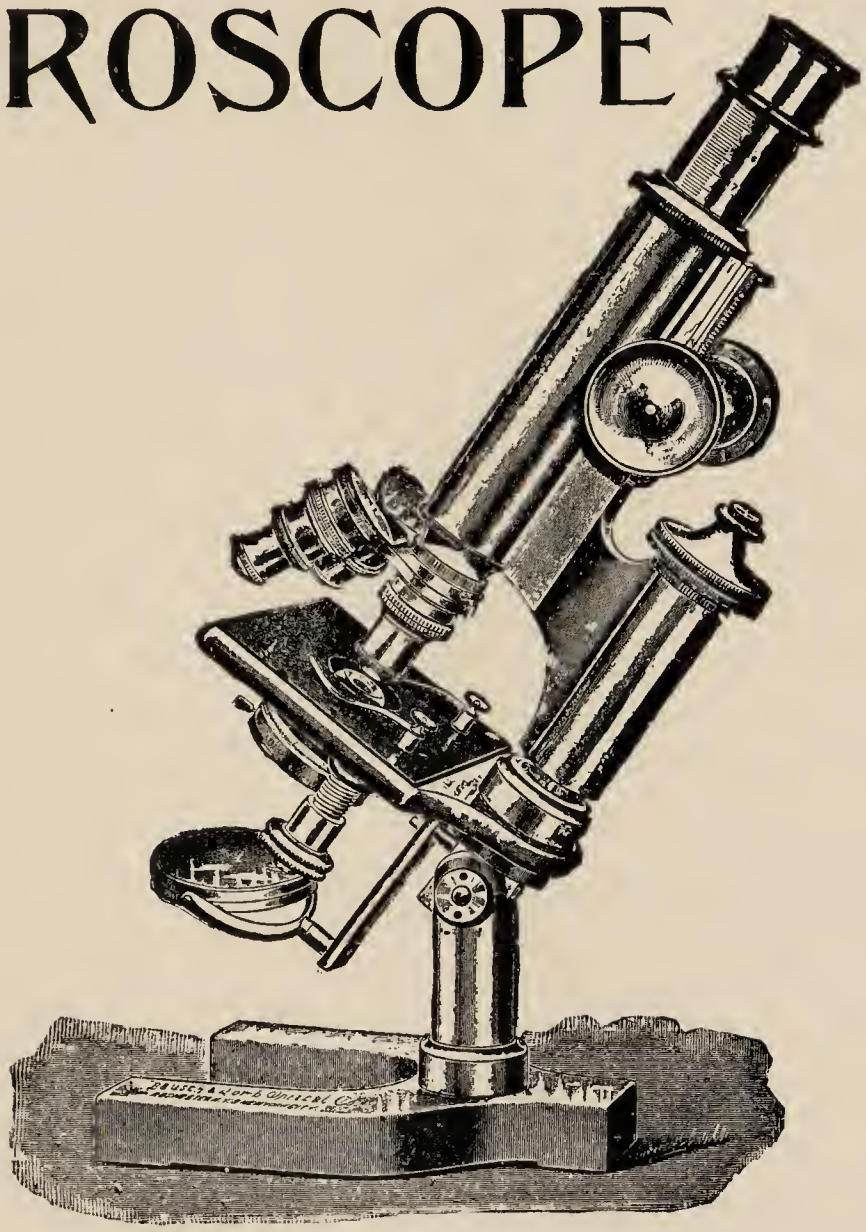
La Nuova Notarisia: Vol. VII. (October, 1896)—Vol. VIII. (January, 1897).

Nuovo Giornale Botanico Italiano: Vol. III., No. 4—Vol. IV., No 1 (October, 1896–January, 1897).

Bullettino della Società Botanica Italiana: 1896, Nos. 8, 9; 1897, No. 1.

WELLCOME LIBRARY INSTITUTE

THE NEW BB CONTINENTAL MICROSCOPE



SEND FOR 1896 CATALOG

New Microscopes, New Microtomes.
New Bacteriological Apparatus,
New and Improved Accessories and
Laboratory Supplies.

NEW PRICES.

BAUSCH & LOMB OPTICAL CO.

130 Fulton Street,

ROCHESTER, N. Y. NEW YORK CITY.